

**NEW YORK STATE
PUBLIC SERVICE COMMISSION**

**Case 15-E-0302 – Proceeding on Motion of the Commission to Implement a
Large-Scale Renewable Program and Clean Energy Standard**

COMMENTS BY RICHARD ELLENBOGEN ON

**An INES Type Scale to Rate BESS Incidents and a Comparison of 50 Years of US
Nuclear Generating Plant Operation with the Past 2-1/2 Years of BESS Operation
in the United States**

May 31, 2026

ABOUT THE AUTHOR

Richard Ellenbogen is an active party in the case, a resident of the State of New York, the CEO of Allied Converters, and welcomes the opportunity to provide comments as requested by the Commission in the above referenced proceeding, issued in the May 18, 2023 “Order Initiating Process Regarding Zero Target”.

He is a Former Bell Labs Engineer that worked in the Power Systems Laboratory there. He has done work on the Utility System with NYSERDA and Con Ed. He also decarbonized his factory starting in 1999 and those measurements resulted in the Public Service Commissions Case 08-E-0751 to reduce power line losses. He was an invited speaker to a PSC Utility Conference in 2008 for that case on Line Loss Reduction that was initiated by Steven Keller of DPS based upon the author’s work at the factory and a paper written at the request of Con Ed after a factory visit. He was the Keynote Speaker at the 2023 Business Council of New York State’s Renewable Energy Conference and an invited speaker at the Dutchess County Chamber of Commerce meeting on Energy. He was an early adopter of renewable technologies going back to the 1990’s and decarbonized both his home and his business two decades ago. Between 2006 and mid-2023, the business recycled or repurposed 100% of its waste and sent nothing to a landfill. From 2023 until the end of 2025, that figure has been 99% recycling/repurposing.

Over the past 20 years, the factory has generated between 60% and 85% of its electrical energy onsite with a carbon footprint approximately 30% - 40% lower than the Con Ed System, even prior to the closing of Indian Point. The total energy costs at the facility were \$1.19 per square foot in 2024 and 2025 whereas the average energy costs in the Northeast United States for a facility of that type are between \$4.00 and \$7.00 per square foot. Despite energy costs increases in NY State and the Con Ed area during that time, the costs there have been flat due to increased investment in energy recovery infrastructure.

Over the past three years, he has explored adding energy storage to the systems at the factory to offset the likelihood of energy failures in the Con Ed service area that have been documented by the NYISO in the 2025-34 Reliability analysis. He has been expecting that this would be a necessity since the CLCPA was passed in 2019 and has written extensively on the subject so the energy storage project has been on the schedule for over six years. An analysis of the proposed project done by the US DOE has indicated that by storing energy generated overnight by the over 70% efficient generation located on-site at the factory, an additional 24% carbon reduction could be obtained.

INTRODUCTION

On February 2, 2026 I filed a document in this case, 15-E-0302, [“The Intrinsic Danger of Siting Utility Scale Lithium Based Energy Storage Systems in Densely Populated Areas”](#), that showed the potential harm to local communities of siting large Lithium based Battery Energy Storage Systems (BESS) in their jurisdictions. The following document expands on that work and clearly shows the major gaps in the BESS technology and in public regulation of it.

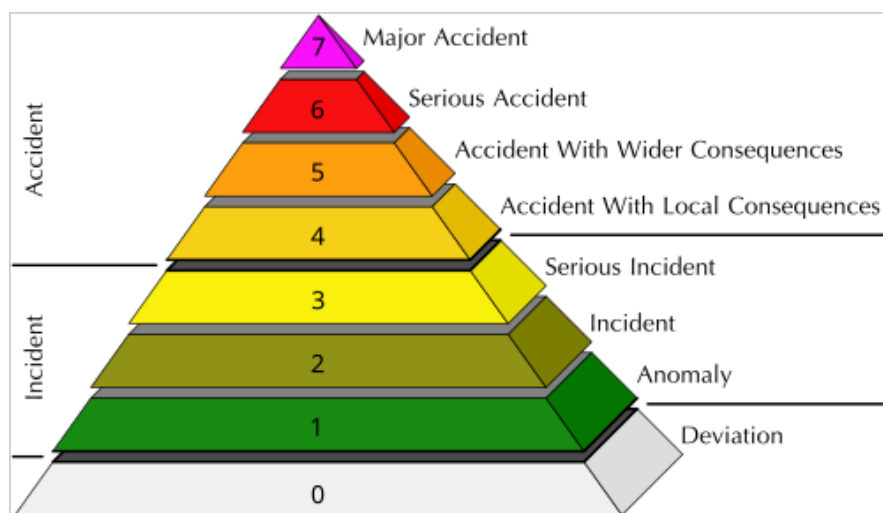
NY State has become the proverbial “Lady that Swallowed the Fly”, with the fly being state energy policy over the past several years that has led to the NYISO warning about blackouts and major generation shortages in the very near future. NY State’s solution, or cure for those years of failed policy, has been to swallow the entire barnyard and all of the animals in it without adequately reviewing the consequences of their actions. For those unfamiliar with the [parable](#), the lady dies at the end.

This is a very ironic situation because over the past 37 years, NY State has decommissioned three functioning nuclear reactors, [Shorham’s](#) 820 MW in 1989 and [Indian Point’s](#) two reactors with a combined 2000 MW capacity between 2020 and 2021. All of the units were shuttered essentially because of public fear of the systems and the associated political pressure.

That makes comparing nuclear plant safety with BESS safety a valid comparison for utility system viability and that is what this document will explain in detail. As the comparisons will show, a nuclear plant is a statistically far safer facility to have located in any community than a BESS System. The nuclear industry is far more regulated and has far more stringent reporting requirements, and as a result over its entire history dating back 65 years, it has caused far less, if any, environmental damage than a BESS industry that is less than a couple of decades old. In spite of that, NY State seems determined to inflict damage on its local communities to try and mitigate the damage from its failed energy policies.

The Nuclear Industry has a strict reporting system for grading and reporting incidents at both nuclear plants and from any organization that handles any type of radiological material. It is called [INES \(International Nuclear and Radiological Event Scale\)](#) Figure 1 shows a graphic representation of the INES levels.

FIGURE 1 – INES Levels (Source – Wikipedia)



This report was generated by asking the following four simple questions of Perplexity AI. All Perplexity responses are in italics. The first two questions are shown below and the last two questions will be presented when there is context for them later in the document. The answer to the first question was, "No". The second question was offered by the AI algorithm in response to the first question. It asked, "*Should I build a comparable scale?*".

1 - Is there a battery failure event scale similar to the INES nuclear scale?

2 - Build a comparison dashboard between the IAEA's INES nuclear safety scale and the NFPA 855 Standard for Stationary Energy Storage Systems. Contrast their methods of categorizing risk, detailing how each approach measures hazard severity (INES uses radioactive release, NFPA 855 uses fire-suppression and containment metrics). Include a summary of how battery industry analysts actually classify 'thermal runaway' events compared to nuclear 'accident' levels 4–7, and synthesize current industry frameworks for reporting site-level battery fires and containment failures into a structured, side-by-side positioning report

None of the questions were leading or biased and the responses were very telling. Having an impartial AI system generate the dashboard removes any human emotion from the analysis, The full responses from Perplexity appear in the appendices 1 – 4 for the associated question. Appendix 5 shows the dashboard that Perplexity constructed. It also shows the severity of the ten BESS incidents in the United States since January 1, 2024, based upon the INES type scale that Perplexity built.

THE INES EVENT REPORTING SCALE and THE BESS EQUIVALENT SCALE

The INES Nuclear event reporting scale was introduced in 1990. Events prior to that date were retroactively graded according to the scale and historical data of each event. The scale in Figure 1 showed that events above a level 4 are those that had an impact on the local community. This document only deals with INES Events in the US Power sector since 1975, a period of over 50 years, and BESS Events in the US Power Sector since January 1, 2024, a period of less than 2-1/2 years.

The third question that was presented to Perplexity was:

How many Level 4 and above INES nuclear incidents have occurred in the United States since 1975?

As is documented in Appendix 3, the response was that there has only been one event in the past 50 years and that was 47 years ago. The only other event, referenced as SL-1 below, occurred in 1961 and that was not a commercial nuclear plant. It was an experimental military reactor built when the nuclear industry was in its infancy. "*Since 1975: one event — Three Mile Island (INES 5). No US nuclear facility incident has been rated Level 4 or higher since TMI. The SL-1 accident is the only other formally rated US event, predating your 1975 threshold by 14 years. There have been no Level 6 or 7 events on US soil at any point in history.*

Summarized in Figure 2 below, are the eight Level 2 and higher events that have occurred at US nuclear plants since 1975. **Radiation release was only associated with the Level 5 event at Three Mile Island** and after 46 years, there have been no deaths associated with that event and no environmental damage. There was one level 3 event in 2002, 24 years ago, and six level 2 events with the latest being 16 years

ago. That was related to an electrical fire in switchgear and not to the reactor. That type of fire also occurs in utility substations and goes unnoticed unless it turns the [night sky blue over NY City](#). No radiation release was associated with the seven Level 2 and Level 3 incidents and there was no local impact from any of them.

FIGURE 2 Level 2+ at US Nuclear Generating Plants Since 1975 — Complete Picture

Here is the full corrected table across all levels, restricted to power reactors only:

Year	Level	Facility	State	Key Facts
1979	5	Three Mile Island Unit 2	PA	Partial core meltdown; ~2M people received avg. 1 mrem above background
1996	2	Wolf Creek Generating Station	KS	Frazil ice blocked intake, forcing manual reactor trip; turbine-driven AFW pump failed; "B" ESW train narrowly stayed operable
1999	2	Indian Point Nuclear Generating Unit 2	NY	Spurious trip, emergency diesel generator output breaker immediately tripped open, de-energizing a safety bus; Unusual Event declared
1999	2	Waterford Steam Electric Station Unit 3	LA	~5,500 gallons of reactor coolant lost to refueling water storage pool during shutdown; Alert emergency declared
2001	2	Point Beach Nuclear Plant Units 1 & 2	WI	Latent design flaw: loss of instrument air could disable AFW system entirely; no backup accumulators existed
2002	3	Davis-Besse Nuclear Power Station	OH	Boric acid corroded 70% through reactor vessel head; 3/16" stainless steel liner all that remained
2005	2	Kewaunee Nuclear Power Plant	WI	Flooding analysis never completed; non-safety piping failure in turbine building could have disabled ESF equipment rooms
2010	2	H.B. Robinson Steam Electric Plant Unit 2	SC	Bus-tie breaker fault caused two sequential fires in switchgear; multiple system failures; upgraded from Level 1 to Level 2 after NRC re-inspection

Total at commercial generating stations since 1975: 8 events one Level 5, one Level 3, and six Level 2.

As a comparison to the nuclear safety record documented above are the ten BESS incidents that have occurred in the United States during a period of 2-1/2 years since January 1, 2024, one twentieth of the timeframe of the nuclear analysis and one sixth of the timeframe since the last Level 2 or higher nuclear incident.

Figure 3 lists the ten incidents based upon the INES/BESS rating system created by Perplexity. There have been two Stage 4 events with major discharge of gases and heavy metals, four Stage 3 events and Four Stage 2 events. Note that two of the Stage 3 events were the newer LFP technology, and the description associated with them is “Better Contained”, not “Fully Contained.” Additionally, “Better” is a very relative term when the bar has been set so low by prior events. Also note the comment about the reporting vacuum regarding sub-ignition events. Contrasted with over 50 years of nuclear plant operation with no environmental damage, the record of Lithium based BESS systems over 1/20th the timeframe with significant environmental damage is abysmal. The full text and description for Figure 3 appears in Appendix 2.

FIGURE 3 – BATTERY INCIDENTS AT US UTILITY SCALE ENERGY STORAGE FACILITIES SINCE 1/1/2024

The section covers all 10 incidents (Jan 2024 – May 2026) with their INES/Battery stage ratings, and includes the cross-incident pattern analysis at the bottom:

- *Two **Stage 4** (Installation Catastrophic) events: Gateway San Diego and Moss Landing — both NMC chemistry, indoor buildings, EPA CERCLA enforcement*
 - *Four **Stage 3** (Propagation) events: Escondido, Royse City, Parkfield, and Glendale-Peoria — notably the two LFP/Megapack incidents (Parkfield, Glendale-Peoria) contained better despite larger nameplate capacity*
 - *Four **Stage 2** (Cell Ignition) events: Santa Ana, Digital Realty Hillsboro, Warwick NY, and San Marcos*
 - *Zero **Stage 0–1** events in the log, reflecting the well-documented reporting vacuum where sub-ignition incidents go unrecorded federally*
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The fourth question that was asked of Perplexity was the following and the AI response appears below it. The full text is in Appendix 4.:

If battery fires release gases and heavy metals, how does that compare to a Level 2 nuclear generator incident that has no radiation release?

This is one of the sharpest analytical points in the entire framework. Let me search for the specific toxicological data to give you hard numbers.

Now I have everything needed to build a rigorous comparison. Let me construct the analysis.

BESS Fire Emissions vs. Level 2 Nuclear Plant Incident: What's Actually Released

*This is one of the most analytically uncomfortable asymmetries in the entire framework. The short answer: **a Level 2 nuclear plant incident releases nothing into the environment by definition, while a Stage 2–4 BESS fire releases a chemically complex, multi-pathway hazardous plume that would trigger federal reporting requirements under almost any other industrial sector.***

In the prior statement, Perplexity was stating that the Stages in its BESS Scale don't correlate on an "Apples to Apples" equivalent with the INES Scale because a Level 2 Nuclear Event is far less impactful on the surrounding environment than its determination of a Stage 2 BESS Event. The effects of that and the chemicals released are documented in Appendix 4 and echo what was presented in the earlier document, "The Intrinsic Dangers.....".

While the newer LFP BESS systems are better, they are not foolproof and they are not as benign as the installers would have you believe.

Further, the statement that **a Stage 2–4 BESS fire releases a chemically complex, multi-pathway hazardous plume that would trigger federal reporting requirements under almost any other industrial sector**, is indicative of the fact that not clearly documenting these events has the "ignorance is bliss" effect on both the public and policy makers.

Perplexity also had the following suggestion regarding Policy Implications for Grid Scale Deployment of BESS Systems:

As utility-scale BESS Installations grow to multi-GWh scale in locations like New York, California, and Texas – often sited in or near dense grid interconnection zones – the absence of a standardized, post event severity classification system creates an analytic blind spot. The nuclear sector's INES framework, for all its limitations, enables regulators to benchmark the severity of events across time and geographies. An equivalent BESS classification standard – one that integrates EUCAR cell-level data, UL 9540A propagation outcomes, and EPRI root cause taxonomy into a unified, publicly reportable Severity number – would represent a significant advancement in grid-level energy storage risk management.

That type of framework does not exist and based upon the lack of information available to the public and their representatives, decisions about these systems are being made in an information vacuum where the only stimulus is BESS money being dangled in front of the noses of towns without any attention being paid to the potential downstream consequences. To understand the full ramifications of this information gap, readers are encouraged to read the full incident histories of the ten events that are documented in Appendix 5. The event history with consequences and evacuations starts on page 35 and the entirety of Appendix 5 was constructed without human intervention or prejudices.

CONCLUSION

The BESS Industry has a far worse safety and environmental record over the past 2-1/2 years than the nuclear industry has over the past 50 years, a period twenty times as long. NY State regulators and policy makers are ignoring these facts and allowing these systems to be installed in populated neighborhoods while also ignoring the potential consequences. The fact that the BESS industry is immune from regulations that would “**trigger federal reporting requirements under almost any other industrial sector**”, clearly documents how far the state and the industry has to go before allowing widespread installations of these systems. Regulators are not ensuring the public’s safety. They are only trying to put a band-aid on years of utility system mismanagement. The unsolicited conclusion generated by Perplexity documents the problem far better than any human could and it follows in italics. While the IAEA would not be the regulating agency for BESS Systems, the Department of Energy could be.

The Regulatory Gap in One Number

*The 6 nuclear plant Level 2 events (1996–2010) all involved **zero radiation release** — pure defense-in-depth degradation. Every one triggered mandatory NRC notification, IAEA submission, and public INES rating. The BESS equivalent — a BMS anomaly, suppression margin reduction, or near-ignition precursor — has **no federal reporting pathway, no IAEA submission, and no public rating requirement**. That asymmetry is the structural argument Section 07 of the dashboard documents in real incident terms.*

*The Level 2 nuclear comparison doesn't show that nuclear is more dangerous than BESS. It shows the **opposite problem**: the nuclear framework is so mature it captures events that cause zero harm, while **the battery framework misses events that cause documented, measurable, multi-pathway environmental harm**.*

Based upon the prior information, the question has to be asked, “From a Public Safety Standpoint, if you’ve decommissioned three nuclear reactors, why would you want to install a BESS facility in populated areas that is far less safe?”

APPENDIX 1-

Is there a battery failure event scale similar to the INES nuclear scale ?

There is no single, globally adopted battery-failure event scale equivalent to the INES nuclear scale; instead, batteries are covered by a patchwork of safety standards, test regimes, and incident classifications depending on application (EVs, grid storage, aviation, etc.). Some sectors use structured severity categories, but nothing as universally recognized and public-facing as INES for nuclear and radiological events.

What INES Does (For Comparison)

The International Nuclear and Radiological Event Scale (INES) is a 0–7, roughly logarithmic scale used in about 60–70 countries to communicate the safety significance of nuclear and radiological incidents to the public and media. Levels 1–3 are “incidents” and 4–7 are “accidents,” with each level intended to represent roughly a ten-fold increase in severity compared to the previous one.

INES is explicitly designed as a communication and harmonization tool across all civil nuclear installations and activities involving radiation sources (facilities, transport, storage, etc.), not just for internal technical analysis.

How Battery Failures Are Treated Today

For batteries (especially Li-ion), safety is mainly handled through:

- *Product and transport test standards (e.g., UN Manual of Tests and Criteria section 38.3 for transport, IEC/UL product safety standards), which define pass/fail criteria for abuse tests rather than a multi-level public severity scale.*
- *Sector-specific safety and reporting frameworks:*
 - *Aviation uses detailed incident/accident reporting with standardized taxonomies for occurrences involving batteries, but not a simple 1–7 public scale.*
 - *EV and grid-storage incidents are usually classified under broader fire, electrical, or industrial accident reporting systems at national or local level.*

These frameworks aim at technical compliance and risk reduction, not at a public-oriented severity ladder like INES.

Why There Isn't an INES-Like Battery Scale

Several factors make an INES-style scale for battery failures less likely (so far):

- *Scope and heterogeneity: Battery incidents span consumer electronics, EVs, aviation, maritime, and grid storage, each with different regulators, loads, geometries, and risk metrics.*

- *Existing risk metrics: Sectors already quantify risk with their own measures (e.g., fire load, toxic gas generation, probability of thermal runaway propagation, casualty counts), which don't map cleanly onto a single global scale.*
- *Communication focus: Nuclear events are rare but high-consequence and politically sensitive, which motivated a unified international communication tool; battery incidents are more frequent but usually localized and handled within sector-specific safety regimes.*

You do see local or company-internal categorization schemes (e.g., "minor cell vent" vs. "container-level thermal runaway" for energy-storage systems), but these aren't standardized globally or widely known outside specialist communities.

Practical Implications for Your Work

If you need something INES-like for batteries in an analytical framework (e.g., grid-scale storage or EV infrastructure), you typically have to:

- *Start from existing safety standards (fire code hazard classifications, thermal runaway test outcomes, maximum credible fire size, gas release rates).*
- *Define your own ordinal scale based on:*
 - *Spatial extent (cell, module, pack, container, building).*
 - *Consequences (no off-site effects, local facility damage, off-site impacts, casualties, long-term environmental damage).*
 - *Response complexity (no intervention, on-site firefighting, off-site emergency response, evacuation).*

That gives you a custom severity index analogous in spirit to INES, but tailored to electrochemical systems and your regulatory/jurisdictional context.

Would you like help designing a quantitative "battery event severity scale" for a specific application (e.g., containerized Li-ion grid storage versus EV depots)?

APPENDIX 2 –

Build a comparison dashboard between the IAEA's INES nuclear safety scale and the NFPA 855 Standard for Stationary Energy Storage Systems. Contrast their methods of categorizing risk, detailing how each approach measures hazard severity (INES uses radioactive release, NFPA 855 uses fire-suppression and containment metrics). Include a summary of how battery industry analysts actually classify 'thermal runaway' events compared to nuclear 'accident' levels 4–7, and synthesize current industry frameworks for reporting site-level battery fires and containment failures into a structured, side-by-side positioning report

Now let me run all the research in parallel:

I now have comprehensive research. Let me build the dashboard.

Now I have everything needed. Let me build the full dashboard:

The dashboard looks excellent — clean typography, proper color coding (indigo for nuclear, amber for battery), and the comparison table is rendering correctly. Let me deploy it.

The dashboard is live. Here's a summary of what's inside across six sections:

Dashboard Structure

01 — Framework Architectures

Side-by-side deep-dive cards for each standard. INES is shown as a three-axis post-event severity descriptor (People & Environment / Radiological Barriers / Defence-in-Depth) with TBq and mSv as primary hazard quantities. NFPA 855 is shown as a four-axis pre-incident compliance framework (Installation Type / Energy Quantity / Suppression Strategy / HMA threshold), with kWh and % of LFL as primary metrics.

02 — Severity Scales Decoded

Full annotated INES 7-level scale with real-world TBq thresholds and event examples (Chernobyl, Fukushima, TMI-2, Kyshtym, Tokaimura). NFPA 855's four installation risk tiers. Full EUCAR cell Hazard Level grid (0–7) with classification criteria.

03 — Thermal Runaway Industry Classification

Five-stage battery analyst framework (Precursor → Gas Venting → Cell Ignition → Unit Propagation → Installation Catastrophic) mapped against EUCAR levels, Sandia/ORNL severity scores, UL 9540A containment tiers, and NFPA 855 response thresholds. Includes Elkhorn/Moss Landing 2025 and Gateway San Diego 2024 as documented real-event examples.

04 — Side-by-Side Positioning

14-row comparison table across dimensions including governing body, scale structure, primary hazard quantity, hazard physics, off-site consequence logic, containment philosophy, timing of rating

assignment, mandatory reporting, and regulatory maturity. Followed by a nuclear Level 4–7 / battery Stage 3–4 analog mapping with explicit caveats where the comparison breaks down (Levels 6–7 have no battery equivalent).

05 — Site-Level Incident Reporting

Four panels detailing nuclear's mandatory CFR 50.72/50.73/IAEA IRS framework against battery ESS's fragmented voluntary system (NFIRS, EPRI database, UL Incident Reporting). Seven critical reporting gap pills highlight where BESS oversight lags nuclear by ~35 years.

06 — Analyst Synthesis

Six synthesis insights culminating in a policy implication note specific to grid-scale BESS deployment in jurisdictions like New York — arguing the case for a unified post-event BESS severity classification standard integrating EUCAR, UL 9540A, and EPRI root-cause taxonomy.

INES vs NFPA 855 Safety Dashboard

Based upon the previously generated scale, please classify battery incidents in the United States since January 1, 2024 on the created INES/Battery Scale

I now have detailed facts on all major incidents. Let me build the new classified section into the dashboard:

The file looks perfect. Now deploy the updated dashboard:

The skill is loaded. Now let me verify the local file is in good shape and then deploy.

Good — the file is at 1,717 lines with both commits in place. Deploying now.

The dashboard is live and the nav bar already shows "07 US Incident Log" as a section tab. The update is deployed successfully.

The dashboard is fully updated and live. Section 07 — US Incident Classification Log — is now accessible via the "07 US Incident Log" tab in the nav bar.

The section covers all 10 incidents (Jan 2024 – May 2026) with their INES/Battery stage ratings, and includes the cross-incident pattern analysis at the bottom:

- *Two **Stage 4** (Installation Catastrophic) events: Gateway San Diego and Moss Landing — both NMC chemistry, indoor buildings, EPA CERCLA enforcement*
- *Four **Stage 3** (Propagation) events: Escondido, Royse City, Parkfield, and Glendale-Peoria — notably the two LFP/Megapack incidents (Parkfield, Glendale-Peoria) contained better despite larger nameplate capacity*
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INES vs NFPA 855 Safety Dashboard

How many Level 4 and above INES nuclear incidents have occurred in the United States since 1975

This is enough to give a precise answer. Let me compile it clearly.

The short answer: **two**, if you count only events since 1975. **Three total** if you include the pre-INES era, going back to 1961.

US Nuclear Events Rated INES Level 4 or Above

INES wasn't adopted until 1990, so ratings for pre-1990 events are retrospective assessments. Here are every event on US soil that has been formally or retrospectively assigned a Level 4 or higher rating:

Level 5 — Accident with Wider Consequences

Three Mile Island Unit 2 — March 28, 1979 | Middletown, Pennsylvania

Loss of coolant and partial core meltdown due to operator error and design flaws. Roughly 2 million people in the area received an average dose of ~1 millirem above background — negligible health impact, but rated INES 5 by the NRC and the most serious commercial nuclear accident in US history. This is the only post-1975 US event at Level 4 or above.

Level 4 — Accident with Local Consequences (pre-1975, for completeness)

SL-1 Experimental Power Station — January 3, 1961 | Idaho Falls, Idaho

A prompt criticality excursion during maintenance (a control rod was manually withdrawn too far) caused a steam explosion that killed all three operators on site — the only fatalities from an acute US reactor accident. Retroactively rated INES 4.

Notable Events Not Formally INES-Rated at Level 4+

Two other events are sometimes cited but did not receive formal Level 4 ratings:

- **Church Rock Uranium Mill Tailings Spill** (July 16, 1979, New Mexico) — The largest single release of radioactive material into the US environment by volume (~94 million gallons, 46 curies released into the Puerco River), exceeding TMI's radioactive release. However, it involved a non-reactor mining/milling facility and has no formal INES classification, as the INES framework is primarily oriented toward reactor and sealed-source events.
 - **Sodium Reactor Experiment (SRE)** (July 1959, Santa Susana, CA) — Roughly one-third of fuel elements were damaged; DOE studies concluded only noble gases were released to the environment. Occurred before the 1975 cutoff and has never received a formal INES rating.
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Summary

Event	Year	INES Level	Within 1975 Scope?
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<i>Three Mile Island Unit 2</i>	<i>1979</i>	<i>5</i>	<i>Yes</i>
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<i>SL-1, Idaho Falls</i>	<i>1961</i>	<i>4</i>	<i>No</i>
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Since 1975: one event — Three Mile Island (INES 5). No US nuclear facility incident has been rated Level 4 or higher since TMI. The SL-1 accident is the only other formally rated US event, predating your 1975 threshold by 14 years. There have been no Level 6 or 7 events on US soil at any point in history.

Summarized here and also in Appendix 3 are all of the eight level 2 and above nuclear events that have occurred in the United States since 1975.

APPENDIX 3 –

How many Level 4 and above INES nuclear incidents have occurred in the United States since 1975 Also Level 2 and Level 3 Events

This is enough to give a precise answer. Let me compile it clearly.

*The short answer: **two**, if you count only events since 1975. **Three total** if you include the pre-INES era, going back to 1961.*

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Summary

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How many level 3 incidents and above in the US in that same time frame Also Level 2

Here's the full picture for the US since 1975, organized by level:

Level 5 — 1 event

Three Mile Island Unit 2 (1979, Pennsylvania) — the only one, as covered previously.

Level 4 — 0 events since 1975

SL-1 was 1961, predating your window. No Level 4 events have occurred in the US since 1975.

Level 3 — 3 events (since 1975, reactor/facility scope)

Date	Facility	State	Notes
Mar 2002	Davis-Besse Nuclear Power Station	Ohio	Boric acid corroded 70% through the reactor vessel head — rated Level 3 by NRC , described at the time as "the most significant INES rating NRC has made since full participation began"
2000– 2002	Industrial Radiography Incident	Illinois	Radiation injury to a radiographer
Sep 2011	Industrial Radiography	Lavaca, Texas	Overexposure to a radiographer trainee's extremities

The 2004 Puerto Rico irradiator event is also documented at Level 3 but occurred at a non-power facility in a US territory.

Davis-Besse is by far the most significant — the reactor head was one thin stainless steel liner (~3/16") from a potential loss-of-coolant accident. It was discovered only because the NRC forced an inspection the plant operator had tried to delay.

Level 2 — 60+ events (since 1990 INES reporting began)

This is where the picture changes dramatically. The [Laka Foundation INES database](#) — which aggregates NRC-to-IAEA submissions — documents roughly 60–70 Level 2 events for the US in total. The breakdown by category:

- **Worker overexposures** (radiographers, industrial workers, researchers) — the single largest category, accounting for roughly half
 - **Lost or stolen radioactive sources** (Ir-192, Co-60 cameras) — approximately a dozen
 - **Nuclear power plant safety system failures** — a handful, including auxiliary feedwater failures and fire-related reactor trips
 - **Public radiation exposures** from equipment failures
 - **Fuel cycle/enrichment incidents** — including an HEU solution spill
 - The most recent formally rated US Level 2 event: **Curium US LLC, Noblesville, Indiana (April 2025)** — two workers exceeded annual dose limits handling ~7.77 TBq of rubidium waste; Worker 1 received 12.4 rem, Worker 2 received 9.6 rem against a 5 rem annual limit
-

The Structural Point for Your Dashboard

This frequency distribution directly mirrors the pattern you've already built into Section 7 for BESS incidents — and makes the regulatory gap even sharper:

INES Level US Nuclear Count (since 1975) BESS Analog US BESS Count (2024–2026)

5	1 (TMI)	Stage 4	2 (Gateway, Moss Landing)
4	0	Stage 3–4	—
3	3	Stage 3	4
2	60+ (since 1990)	Stage 1–2	~4 documented; unknown actual

Nuclear Level 2 events are federally reported, IAEA-submitted, and publicly searchable. The BESS equivalents — worker overexposures, gas venting events, contained cell ignitions — have **no federal reporting requirement** and no equivalent public database. The ~60 nuclear Level 2 events represent a floor of transparency; the BESS equivalent is effectively zero.

How many of the level 2 incidents were at nuclear generating plants? Please redo the list

The answer: **6 of the ~117 Level 2 events were at commercial nuclear generating stations** — roughly 5%. The other 95% were industrial radiography overexposures, stolen sources, nuclear medicine incidents, and fuel cycle facility events.

Level 2+ at US Nuclear Generating Plants — Complete Picture

Here is the full corrected table across all levels, restricted to power reactors only:

Year	Level	Facility	State	Key Facts
1979	5	Three Mile Island Unit 2	PA	Partial core meltdown; ~2M people received avg. 1 mrem above background
1996	2	Wolf Creek Generating Station	KS	Frazil ice blocked intake, forcing manual reactor trip; turbine-driven AFW pump failed; "B" ESW train narrowly stayed operable
1999	2	Indian Point Nuclear Generating Unit 2	NY	Spurious trip, emergency diesel generator output breaker immediately tripped open, de-energizing a safety bus; Unusual Event declared
1999	2	Waterford Steam Electric Station Unit 3	LA	~5,500 gallons of reactor coolant lost to refueling water storage pool during shutdown; Alert emergency declared
2001	2	Point Beach Nuclear Plant Units 1 & 2	WI	Latent design flaw: loss of instrument air could disable AFW system entirely; no backup accumulators existed
2002	3	Davis-Besse Nuclear Power Station	OH	Boric acid corroded 70% through reactor vessel head; 3/16" stainless steel liner all that remained
2005	2	Kewaunee Nuclear Power Plant	WI	Flooding analysis never completed; non-safety piping failure in turbine building could have disabled ESF equipment rooms
2010	2	H.B. Robinson Steam Electric Plant Unit 2	SC	Bus-tie breaker fault caused two sequential fires in switchgear; multiple system failures; upgraded from Level 1 to Level 2 after NRC re-inspection

Total at commercial generating stations since 1975: 8 events — one Level 5, one Level 3, and six Level 2.

Level 2 — Non-Power-Plant Events (~111 events)

Category	Approx. Count	Illustrative Examples
<i>Industrial radiography overexposures</i>	~65	<i>Ir-192 / Co-60 source mishandling; cameramen exceeding annual dose limits</i>
<i>General radiation worker overexposures</i>	~25	<i>Non-radiography workers at various licensed facilities</i>
<i>Public overexposures</i>	~6	<i>Failed fixed gauging device; 15-member public exposure event</i>
<i>Nuclear medicine / radiopharmacy</i>	~5	<i>Nuclear pharmacist trainee; nuclear medicine technologist overexposures</i>
<i>Fuel cycle / uranium processing</i>	~4	<i>HEU solution spill; uranium accumulation in glove box scrubber</i>
<i>Lost or stolen sources</i>	~4	<i>Stolen Ir-192 cameras; stolen Category 2 source</i>
<i>Research reactor</i>	1	<i>Texas A&M research reactor extremity overexposure</i>
<i>Most recent (2025)</i>	1	<i>Curium US LLC, Noblesville IN — two workers exceeded annual limit handling 7.77 TBq rubidium waste</i>

*The core analytical point for your dashboard: the 6 nuclear plant Level 2 events spanning 14 years (1996–2010) all involved **defense-in-depth degradation with no radiation release** — exactly the type of near-miss reporting that doesn't exist at all for BESS. Wolf Creek, Indian Point, and Waterford all triggered formal NRC review, IAEA notification, and public INES rating within weeks of discovery. A comparable BESS event — say, a BMS failure that narrowed suppression margins without ignition — generates no federal report, no IAEA submission, and no public rating.*

Compiling the corrected INES Level 2+ US nuclear power plant events table and delivering the full redone list.

US Nuclear Events INES Level 2 and Above — Power Reactors Only

8 total events at commercial generating stations since 1975 — one Level 5, one Level 3, six Level 2:

Year	Level	Facility	State	What Happened
1979	5	Three Mile Island Unit 2	PA	<i>Partial core meltdown; small radioactive gas release; ~2M nearby residents received avg. 1 mrem above background</i>
1996	2	Wolf Creek Generating Station	KS	<i>Frazil ice blocked cooling water intake, forcing manual reactor trip from 80% power; turbine-driven auxiliary feedwater pump later failed; backup ESW train narrowly stayed operable</i>
1999	2	Indian Point Unit 2	NY	<i>Spurious trip signal; emergency diesel generator output breaker opened immediately, de-energizing a safety bus; Unusual Event declared</i>
1999	2	Waterford Steam Electric Unit 3	LA	<i>~5,500 gallons of reactor coolant lost to refueling water storage pool during shutdown; Alert emergency classification declared</i>
2001	2	Point Beach Units 1 & 2	WI	<i>Latent design flaw discovered: loss of instrument air could disable the entire auxiliary feedwater system; no backup accumulators existed</i>
2002	3	Davis-Besse	OH	<i>Boric acid corroded 70% through the reactor vessel head; only 3/16" stainless steel liner remained; NRC called it the most significant INES rating since full US participation began</i>
2005	2	Kewaunee Nuclear Power Plant	WI	<i>Flooding analysis never performed; turbine building pipe failure could have flooded ESF equipment rooms containing diesel generators, AFW pumps, and safety switchgear</i>
2010	2	H.B. Robinson Unit 2	SC	<i>Bus-tie breaker fault caused two sequential switchgear fires; charging pump failure, DC bus grounds, and temporary loss of component cooling water all followed; upgraded from Level 1 to Level 2 after NRC reactive inspection</i>

Level 2 — Non-Power-Plant Events (~111 events)

These make up ~93% of all US Level 2 events. The [Laka Foundation database](#) documents them all.

Category	Count	Notes
Industrial radiography overexposures	~65	Ir-192 / Co-60 source mishandling; workers exceeding annual dose limits
General radiation worker overexposures	~25	Various licensed facilities
Public overexposures	~6	Failed gauging device; 15-member public exposure event
Nuclear medicine / radiopharmacy	~5	Pharmacist trainees; nuclear medicine technologists
Fuel cycle / uranium processing	~4	HEU solution spill; uranium accumulation in glove box air scrubber
Lost or stolen radioactive sources	~4	Stolen Ir-192 cameras; stolen Category 2 source
Research reactor	1	Texas A&M extremity overexposure
Most recent (Apr 2025)	1	Curium US LLC, Noblesville IN — two workers exceeded annual limits handling 7.77 TBq rubidium waste

The Regulatory Gap in One Number

The 6 nuclear plant Level 2 events (1996–2010) all involved **zero radiation release** — pure defense-in-depth degradation. Every one triggered mandatory NRC notification, IAEA submission, and public INES rating. The BESS equivalent — a BMS anomaly, suppression margin reduction, or near-ignition precursor — has **no federal reporting pathway, no IAEA submission, and no public rating requirement**. That asymmetry is the structural argument Section 07 of the dashboard documents in real incident terms.

APPENDIX 4 -

If battery fires release gases and heavy metals, how does that compare to a Level 2 nuclear generator incident that has no radiation release?

This is one of the sharpest analytical points in the entire framework. Let me search for the specific toxicological data to give you hard numbers.

Now I have everything needed to build a rigorous comparison. Let me construct the analysis.

BESS Fire Emissions vs. Level 2 Nuclear Plant Incident: What's Actually Released

*This is one of the most analytically uncomfortable asymmetries in the entire framework. The short answer: **a Level 2 nuclear plant incident releases nothing into the environment by definition, while a Stage 2–4 BESS fire releases a chemically complex, multi-pathway hazardous plume that would trigger federal reporting requirements under almost any other industrial sector.***

What a Level 2 Nuclear Plant Event Actually Is

*All six US nuclear plant Level 2 events involved **zero off-site release**. INES Level 2 at a power reactor is rated entirely on the defense-in-depth axis — a safety barrier was weakened or a redundant system failed, but the remaining layers held. The [NRC's own Davis-Besse rating memo](#) describes Level 2/3 as events where "this condition, if not discovered, could have directly led to an accident." The hazard is potential, not realized.*

Radiological release to environment: zero.

Community impact: zero.

EPA involvement: none.

CERCLA trigger: none.

What a Stage 2–4 BESS Fire Actually Releases

Toxic Gases (acute inhalation hazard)

From TEEX/SwRI NMC battery emissions testing and the Larsson et al. PMC study:

Compound	OSHA PEL	Measured Exceedance	Health Significance
Carbon monoxide (CO)	50 ppm (8-hr)	500× PEL	Acute asphyxiant

Compound	OSHA PEL	Measured Exceedance	Health Significance
Formaldehyde (CH ₂ O)	0.75 ppm (8-hr)	150× PEL	Carcinogen, respiratory irritant
Ethylene	1 ppm (8-hr)	446× PEL	Asphyxiant, flammable
1,3-Butadiene	1 ppm (15-min)	26× limit	Group 1 IARC carcinogen
Hydrogen fluoride (HF)	—	IDLH = 30 ppm	Systemic toxin; causes pulmonary edema, bone destruction
Hydrogen cyanide (HCN)	—	Detected	Cellular asphyxiant; ~50 ppm immediately dangerous
Particulate matter (PM _{2.5})	9 µg/m ³ (EPA ambient)	12,000–17,000× EPA standard	Respiratory, cardiovascular

For HF specifically: Larsson et al. measured **20–200 mg HF per Wh** of battery capacity. Scaled to facility size:

- 100 kWh system → **2–20 kg HF** released
- 1,000 kWh system → **20–200 kg HF** released
- Moss Landing Phase 1 (1,200,000 kWh, ~75% destroyed) → **theoretical upper bound: ~180,000 kg HF** (actual dispersed/reacted fraction far lower, but the generation potential is enormous)

The IDLH for HF is 30 ppm. The 10-minute lethal threshold (AEGL-3) is 170 ppm.

Heavy Metal Particulates (persistent environmental contamination)

From the Nature/Moss Landing wetland study:

- **~25 metric tons** of Ni, Mn, and Co cathode metals deposited across **1.2 km²** of Elkhorn Slough wetlands
- That 25 metric tons represents **less than 2%** of the estimated total cathode material released — meaning ~98% went elsewhere (soil, ocean, suppression water)
- Post-fire nickel surface concentrations exceeded **50 ppm** — the threshold associated with toxicity risks to plants and aquatic organisms — at most sampled locations
- Cobalt concentrations rose by **5×** above baseline; nickel by **an order of magnitude**
- The contaminated area is a **tidal wetland restoration zone** — cobalt has documented lethal/sublethal effects on fish and crustacean reproduction

The [EPA classified Moss Landing under CERCLA](#) as a hazardous substance release. Gateway San Diego similarly triggered [EPA CERCLA enforcement](#) with 2.5 million lbs of fire-damaged batteries and 5 million gallons of contaminated suppression water requiring disposal.

The Regulatory Inversion

This is the structural absurdity the dashboard documents:

Dimension	Level 2 Nuclear Plant Event	Stage 3–4 BESS Fire
Radiological/chemical release	Zero	HF, HCN, CO, heavy metals, VOCs
Off-site community impact	None	Evacuations (500 businesses to 1,500 residents)
Ecosystem contamination	None	25 metric tons of heavy metals across 1.2 km ² wetland (Moss Landing)
Federal reporting requirement	Mandatory (10 CFR 50.72, IAEA INES submission)	None
Public INES/equivalent rating	Yes — published within weeks	None exists
EPA CERCLA involvement	Not triggered	Triggered at both Stage 4 US events
Regulatory maturity	35+ years of mandatory near-miss reporting	Zero federal near-miss reporting requirement

A Wolf Creek or Waterford operator that degraded a safety system with **no release and no community impact** was required to notify the NRC within hours, submit a Licensee Event Report within 60 days, and have the event rated and submitted to the IAEA. A BESS operator whose facility deposited 25 metric tons of heavy metals across a protected coastal wetland — contaminating it at levels toxic to aquatic organisms — had **no equivalent federal reporting obligation at the time of the fire**.

The Level 2 nuclear comparison doesn't show that nuclear is more dangerous than BESS. It shows the **opposite problem**: the nuclear framework is so mature it captures events that cause zero harm, while the battery framework misses events that cause documented, measurable, multi-pathway environmental harm.

APPENDIX 5 –

COMPARISON OF INES WITH A PERPLEXITY GENERATED BESS TYPE SCALE THAT EQUATES TO INES. THE AI GENERATED INES TYPE SCALE FOR BESS APPEARS ON THE FOLLOWING PAGES

AN ANALYSIS OF THE TEN MAJOR BESS EVENTS THAT HAVE OCCURRED IN THE UNITED STATES SINCE JANUARY 1, 2024 IS ALSO PRESENTED.

NOTE THAT TWO OF THE EVENTS, BOTH CLASSIFIED BY PERPLEXITY AS “LEVEL 3” EVENTS INVOLVED THE NEWER LFP TECHNOLOGY.

TWO OF THE AI GENERATED CONCLUSIONS ARE VERY TELLING:

*“Root cause has not been officially confirmed for any of the 10 incidents listed. This classification was conducted from entirely public sources - illustrating the **mandatory reporting vacuum** identified in section 05.*

POLICY IMPLICATION FOR GRID-SCALE DEPLOYMENT

As utility-scale BESS installations grow to multi-GWh scale in locations like New York, California, and Texas — often sited in or near dense grid interconnection zones — the absence of a standardized, post-event severity classification system creates an analytic blind spot. The nuclear sector’s INES framework, for all its limitations, enables regulators to benchmark the severity of events across time and geographies. An equivalent BESS event classification standard — one that integrates EUCAR cell-level data, UL 9540A propagation outcomes, and EPRI root-cause taxonomy into a unified, publicly reportable severity number — would represent a significant advancement in grid-level energy storage risk management.

01 Framework Architectures

Each standard was built around a fundamentally different hazard physics — dispersive radiological contamination vs. contained thermochemical energy release — producing incompatible risk ontologies.



IAEA INES — International Nuclear and Radiological Event Scale

Est. 1990 • IAEA / OECD-NEA • Current: 2008 User's Manual

Levels

7 + 10

Scale Type

Logarithmic

Member States

~170

PURPOSE

Communicate severity of nuclear and radiological events to regulators, governments, and the public in a standardized way across all IAEA member states.

THREE AXES

- (1) **People & Environment** — radioactive release magnitude, public dose
- (2) **Radiological Barriers & Controls** — barrier integrity, core damage
- (3) **Defence-in-Depth** — failure of layered safety provisions

Final rating = highest score across all three axes.

PRIMARY METRIC

Quantity of radioactive material released, expressed in **TBq equivalent of ^{137}I** .
For lower levels: public effective dose in **mSv** and worker dose in **Sv**.

LOGARITHMIC RULE

Each step up the scale represents roughly **10× greater severity**. Levels 1–3 = "Incidents"; Levels 4–7 = "Accidents." Events with no safety significance are classified **Below Scale / Level 0**.

WHO RATES?

National nuclear regulators (e.g. NRC in the US, CNSC in Canada, ASN/ASNR in France) issue provisional ratings; IAEA confirms final ratings. NRC reports events ≥ Level 2 or those attracting international public interest.

SCOPE EXCLUSIONS

Not used for emergency response decisions. Does not cover naturally occurring radioactive material (NORM) in most applications. Ratings can change as events evolve.



NFPA 855 — Standard for the Installation of Stationary Energy Storage Systems

NFPA • Editions: 2020, 2023, 2026 (current)

Editions

3 (2020–26)

Max. Li-ion MAQ

600 kWh

Group Limit

50 kWh

PURPOSE

Define prescriptive and performance-based installation, containment, and fire safety requirements for all stationary ESS technologies. Enforced through NFPA 1 (Chapter 52) and referenced in IFC 2024 (Section 1207).

FOUR AXES

- (1) **Installation Type** — indoor dedicated, indoor non-dedicated, outdoor ≤100 ft, outdoor remote
- (2) **Energy Quantity** — group limits (50 kWh), MAQ thresholds (600 kWh Li-ion)
- (3) **Suppression/Explosion Strategy** — NFPA 69 (prevention) vs. deflagration management
- (4) **Hazard Mitigation Analysis** — triggers above-MAQ "high hazard occupancy" classification

PRIMARY METRIC

Stored energy in **kWh** per fire area; UL 9540A thermal runaway test propagation outcomes (cell → module → unit → installation level containment). Heat release rate (**kW/m²**) informs separation distances.

SEVERITY LOGIC

No post-event numerical rating. Risk is pre-incident and prescriptive: compliance or non-compliance, not a scaled severity index. The **2026 edition** shifts from reactive suppression to explosion prevention by default (NFPA 69), acknowledging fire suppression is rarely effective against Li-ion thermal runaway.

WHO ENFORCES?

Authority Having Jurisdiction (AHJ) — typically local fire marshal / building official. No federal BESS incident reporting mandate exists as of 2025. Emergency Response Plans submitted to AHJ at commissioning.

KEY COMPANION STANDARDS

UL 9540A — thermal runaway propagation test | **UL 9540** — system listing | **NFPA 69** — explosion prevention | **NFPA 13** — sprinkler where required

INES uses a unified 7-level post-event classification. NFPA 855 uses a pre-incident prescriptive threshold system. The battery sector additionally uses the EUCAR cell-level Hazard Levels (0-7) and UL 9540A's four-tier propagation test as proxy severity metrics.

INES 7-LEVEL NUCLEAR SCALE

7

Major Accident ACCIDENT

Major release of radioactive material with widespread health and environmental consequences requiring extensive, long-term countermeasures.

Release: $>10,000$ TBq_{131I} I-equiv. Off-site: Severe, wide-area contamination

Fatalities: Possible radiation deaths

Real events: Chernobyl Unit 4 (1986) — est. 5,200,000 TBq; Fukushima Daiichi (2011) — est. 520,000-940,000 TBq (10-20% of Chernobyl)

6

Serious Accident ACCIDENT

Significant release likely to require implementation of planned countermeasures (shelter, iodine distribution, evacuation of nearby population).

Release: $\sim 1,000$ - $10,000$ TBq_{131I} I-equiv. Off-site: Full countermeasures needed

Real event: Kyshtym disaster (USSR, 1957) — chemical explosion in nuclear waste tank

5

Accident with Wider Consequences ACCIDENT

Limited off-site release likely requiring some planned countermeasures; severe damage to reactor core or radiological barriers; several deaths from radiation possible.

Release: ~ 100 - $1,000$ TBq_{131I} I-equiv. Off-site dose: Possible public exposure

Core damage: Significant fuel melt ($>0.1\%$ core inventory released)

Real events: Three Mile Island TMI-2 (1979) — no radiation deaths; Windscale fire (UK, 1957)

4

Accident with Local Consequences ACCIDENT

Minor release of radioactive material unlikely to result in planned countermeasures beyond local food controls; at least one radiation death; significant on-site release.

Release: ~ 1 - 100 TBq_{131I} I-equiv. (off-site) On-site: Several thousand TBq within facility

Doses: 1 death from radiation; workers >1 Sv/hr in area

Real events: Tokaimura criticality accident (Japan, 1999); Saint-Laurent A2 fuel melt (France, 1980)

3

Serious Incident INCIDENT

Near-miss with no safety provisions remaining. Exposure in excess of $10\times$ statutory annual limit for workers. Non-lethal deterministic effects. No off-site hazard.

Worker dose: >250 mSv ($10\times$ annual limit) Barriers: Severe contamination on-site

Max Level for pure defence-in-depth failures

2

Incident INCIDENT

Significant failures in safety provisions without actual consequences, Worker overexposure above statutory annual limit (>20 mSv whole body). Public dose >10 mSv.

Worker dose: >20 mSv (statutory annual limit breach) Public dose: >10 mSv

Minimum level triggering mandatory IAEA reporting by NRC

1

Anomaly INCIDENT

Anomaly beyond authorized operating regime. No off-site consequences, no public exposure. Minor safety significance. Slight degradation of defence-in-depth.

No dose consequences Minor barrier or procedural violation

NFPA 855 — INSTALLATION RISK TIERS

NFPA 855 does not assign post-event severity numbers. Risk tier is determined by installation type and stored energy quantity, which drives prescriptive requirement stringency.

NFPA 855 does not assign post-event severity numbers. Risk tier is determined by installation type and stored energy quantity, which drives prescriptive requirement stringency.

HIGH

Indoor Non-Dedicated-Use Building — Above MAQ

Most stringent regulation. ESS shares occupancy with personnel and other uses. High consequence from gas accumulation, explosion, and toxic release indoors.

Li-ion MAQ: 600 kWh

Group spacing: 50 kWh / 3 ft

Explosion: NFPA 69 prevention required

HMA: Mandatory above MAQ

UL 9540A: Required at installation level

MEDIUM

Indoor Dedicated-Use ESS Building

ESS-only building. No mixed occupancy. Somewhat less stringent due to singular hazard profile, but full explosion prevention and LSFT required under 2026 edition.

Explosion control: NFPA 69

Fire containment: Burn-out strategy preferred over suppression

LSFT: Required under NFPA 855:2026

MEDIUM

Outdoor Installation — Within 100 ft of Exposures

Outdoor siting near inhabited structures. Requires full explosion/fire provisions. Permanent water supply for fire protection (may be waived by AHJ for remote sites).

Setback: ≤ 100 ft to exposures

Suppression: Required where feasible

Gas detection: Mandatory with safety interlocks

LOW

Outdoor Remote — More than 100 ft from Exposures

Least stringent regulation category. AHJ may waive permanent water supply. Utility-scale BESS typically deployed here. Still requires UL 9540A and explosion control provisions.

Setback: > 100 ft

Water: May be waived by AHJ

Explosion: NFPA 69 still required

The EUCAR framework — developed by the European Council for Automotive R&D — classifies individual battery cell test outcomes. It is used by manufacturers for design validation and by labs for test chamber safety rating. This is the closest battery-industry analog to a numeric severity scale.

0

No Effect

No defect, leakage, venting, fire, rupture, explosion, or thermal runaway. Cell reversibly damaged.

1

Passive Protection Activated

Cell protection device triggered. No leakage, venting, fire, rupture, or explosion. Cell reversibly damaged; protection device needs repair.

2

Defect / Damage

Same as Level 1 but irreversible cell damage. No leakage, venting, fire, rupture, or explosion. Cell must be replaced.

Electrolyte: Contained

3

Leakage

Electrolyte leakage without venting, fire, flame, rupture, or explosion.

Mass loss: <50% electrolyte weight

4

Venting

Significant electrolyte venting. No fire, flame, rupture, or explosion. Hazardous/flamable gases released.

Mass loss: ≥50% electrolyte weight

5

Fire or Flame

Cell ignites. No rupture or explosion (no flying parts). Thermal runaway has propagated to combustion. First level commonly equated with "thermal runaway" in field incidents.

6

Rupture

Cell casing mechanically fails. Flying parts of active mass but no full explosion. Risk of shrapnel and secondary ignition.

7

Explosion

Complete cell disintegration. High-velocity fragments, overpressure wave. Highest cell-level hazard. Equivalent to "energetic event" triggering NFPA 855 explosion provisions.

Battery Industry analysts do not use a single unified thermal runaway severity scale — instead, they triangulate across EUCAR cell-level outcomes, UL 9540A propagation containment tiers, and EPRI's root-cause failure taxonomy. The following cards map how practitioners actually categorize these events.

Stage 0 — Precursor

Electrical or thermal abuse conditions develop. BMS detects anomalies (voltage deviation, temperature rise). No visible external symptom.

- **EUCAR: 1-2** — protection activated or defect/damage
- **UL 9540A: Cell level** — thermal runaway induced but not propagated
- **NFPA 855:** BMS alert; no code-triggering event yet

Stage 1 — Gas Venting / Off-Gas

Cell venting occurs. Flammable, toxic gases released (CO, HF, HCN, HC). Visible vapor plume. No fire yet. Critical decision point for suppression activation.

- **EUCAR: 3-4** — leakage to full venting
- **Sandia Severity: 4 (H, 75-90)** — cell puff, gas release, voltage drop to near zero
- **NFPA 855:** CCR system activates; explosion risk monitoring

Stage 2 — Cell Ignition (TR Event)

Full thermal runaway. Cell self-heats uncontrollably. Fire or flame. This is the primary "thermal runaway event" referenced in industry incident databases (EPRI, UL). Containment to module level is the first mitigation goal.

- **EUCAR: 5** — fire or flame, no rupture
- **Sandia Severity: 5 (VH, 90-100)** — heating spread, heavy smoke, fire
- **UL 9540A: Module level** — test passes if TR is contained within module
- **NFPA 855:** 911 call threshold; emergency response plan activated

Stage 3 — Propagation (Unit-Level)

Thermal runaway spreads from originating cell/module to adjacent modules within the same rack or unit. Major fire. High heat release rate. Possible rupture/explosion of enclosure.

- **EUCAR: 6** — rupture (flying parts)
- **UL 9540A: Unit level** — pass requires target wall $\Delta T \leq 97^\circ\text{C}$, no explosion
- **NFPA 855:** Suppression inadequate; isolation zone (≥ 330 ft) established
- **Reported incidents:** Elkhorn/Moss Landing (2022), APS Surprise AZ (2019)

Stage 4 — Installation-Level Catastrophic Failure

Fire exceeds originating unit and spreads across the installation. Explosion(s) possible. Community evacuation may be required (as in Moss Landing 2025: ~1,200 residents). Persistent multi-day fire potential. Environmental contamination from electrolyte, HF, metals.

- **EUCAR: 7** — explosion (disintegration)
- **UL 9540A: Installation level fail** — fire spreads beyond originating unit
- **NFPA 855:** Evacuate / shelter-in-place; EPA involvement; hazmat response
- **Reported incidents:** Moss Landing Elkhorn 2025; Gateway San Diego 2024 (7-day flare-ups)

EPRI Root-Cause Taxonomy

The EPRI BESS Incident Database (81+ incidents as of 2024) classifies by *root cause* and *failed element*, not by outcome severity — a fundamental difference from INES post-event severity scoring.

- **Root Causes:** Design - Manufacturing - Integration/Assembly/Construction - Operation
- **Failed Elements:** Cell/Module - Controls (BMS/EMS) - Balance of System (BOS)
- **Key gap:** No severity tier on the incident record — only cause and element type
- **Transparency:** No mandatory reporting; legal barriers inhibit root-cause disclosure

64 Side-by-Side Positioning

Direct comparison across 14 analytical dimensions. Fundamental architectural differences between the two frameworks mean they are measuring different quantities — not the same risk

Safety Risk Intelligence			Frameworks	Scales	Thermal Runaway	Comparison	Reporting	
INES + NFPA 855 Comparison			01 Frameworks	02 Severity Scales	03 Thermal Runaway	04 Side-by-Side	05 Reporting	06 Synthesis
GOVERNING BODY	IAEA / OECD-NEA — international, consensus-based. National regulators issue ratings.	NFPA (consensus standard); enforced by local AHJ. No federal BESS oversight equivalent to NRC.						
SCALE STRUCTURE	Unified 7-level logarithmic post-event severity scale. Each level = 10x more severe.	No unified post-event scale. EUCAR (0–7) = cell-level test outcome; UL 9540A = propagation containment tiers; NFPA 855 = pre-incident installation thresholds.						
PRIMARY HAZARD QUANTITY	Radioactive material released: TBq of ¹³⁷I-equivalent . Off-site dose in mSv/Sv .	Stored energy: kWh per fire area / group . Heat release rate: kW/m² . Gas concentration: % of LFL .						
HAZARD PHYSICS	Dispersive — ionizing radiation and radionuclide contamination migrate through air, water, food chains. Long-term exposure risk persists for decades.	Localized thermochemical — fire, explosion, toxic gas (HF, CO, HCN). Plume is acute and local. Contamination limited to electrolyte and combustion products.						
OFF-SITE CONSEQUENCE	Drives scale definition from Level 4 upward. Level 7: continent-scale contamination possible. Evacuation zones up to 30 km.	Addressed through setback distances (>330 ft isolation zone for utility BESS), shelter-in-place up to 1 mile. Not built into a severity number.						
CONTAINMENT PHILOSOPHY	Multiple passive barriers: fuel cladding → pressure vessel → containment building → emergency core cooling. Successive barrier failures escalate INES level.	Single active layer: explosion prevention (NFPA 69) + fire containment (burn-out strategy). 2026 edition: LSFT proves adjacent units not at risk. No equivalent multi-barrier grading.						
WHEN RATING ASSIGNED	Post-event — provisional rating during, final after event concludes. Can be revised upward (Fukushima: 4 → 5 → 7 over weeks).	Pre-incident compliance (NFPA 855). EUCAR/UL 9540A ratings assigned during design testing, before deployment. No real-time incident severity number exists in field practice.						
MANDATORY REPORTING	Level ≥2 events: NRC must transmit to IAEA. Emergency notifications to states within hours. CFR 50.72 requires immediate notification for significant reactor events.	No federal requirement. NFIRS (FEMA) captures fire incidents voluntarily. NERIS system in development. NY State encouraged OEM disclosure of RCAs but stopped short of mandate.						
PUBLIC COMMUNICATION	INES number explicitly designed for public communication. Standardized descriptive labels (e.g. "Major Accident") used in all member states.	No standardized public-facing severity label. EPA, fire departments, and utilities use ad hoc descriptions. Public communication varies by jurisdiction.						
TEMPORAL PROFILE	Acute + chronic. Radiation dose is immediate; environmental contamination persists for years to decades (Cs-137 half-life: 30 years).	Acute only. Li-ion fires burn hot and fast (minutes to hours). Multi-day flare-up risk (Gateway 2024: 7 days). No long-term isotopic contamination equivalent.						
WORKER DOSE THRESHOLD	Level 2: Worker dose >20 mSv (statutory annual limit). Level 3: >250 mSv. Level 4: doses causing deterministic effects.	NFPA 855 does not set worker dose thresholds. OSHA PEL governs HF (<0.5 ppm TWA). NFPA 70E sets arc flash PPE for >100 V DC systems.						
TEST/VALIDATION STANDARD	No pre-installation test for severity classification. Safety cases based on probabilistic risk assessment (PRA) and deterministic analysis.	UL 9540A : mandatory pre-installation thermal runaway propagation test at cell, module, unit, and installation levels. LSFT (2026): large-scale fire test of full containers.						
REGULATORY AUTHORITY	Strong, centralized. NRC (US), ONR (UK), ASN (France) with statutory enforcement powers. International IAEA oversight.	Fragmented. Local AHJ has final authority. No equivalent to NRC for BESS. State-level variation significant (CA vs. NY vs. TX fire code adoption).						
GAP / MATURITY	Mature, 35-year operating history. Broad incident database. Strong international harmonization.	Rapidly evolving (three NFPA 855 editions in 6 years). Incident database limited (EPRI: 81 incidents, <33% with sufficient root-cause data). No harmonized severity classification across jurisdictions.						

Battery analysts often face pressure to characterize BESS incidents in terms the public understands. The mapping below reflects how analysts informally position these events — with important caveats that the hazard physics are fundamentally different.

INES Level 4

Accident with Local Consequences

1 radiation death; on-site release of several thousand TBq; food controls required. Local evacuation possible.

• analogous to

Battery: Stage 3 — Unit Propagation

Multi-unit BESS Fire, On-Site Containment Failure

TR propagates beyond module to rack/unit. Major on-site fire. Worker injury risk. Local shelter-in-place may be ordered. Environmental contamination from HF/metals. *No radiation equivalent; no long-range contamination.*

INES Level 5

Accident with Wider Consequences

100–1,000 TBq off-site release; limited planned countermeasures; severe core damage. Some public radiation exposure.

• rough analog

Battery: Stage 4 — Installation Catastrophic

Full Facility Loss + Community Evacuation

Multi-container fire/explosions. Prolonged (days) burn. Community evacuation (Moss Landing 2025: 1,200 residents). EPA involvement. Air quality monitoring required. *Scale of community impact is loosely analogous; persistent contamination is not.*

INES Levels 6-7

Serious / Major Accident

>1,000→10,000 TBq release; wide-area contamination; long-term exclusion zones; potential mass-casualty radiological emergency.

⚠ no true analog

Battery: No Equivalent

No Battery Event Reaches This Magnitude

The dispersive radioactive contamination of INES 6-7 events has no equivalent in any known BESS scenario. Li-ion chemistry does not produce long-lived radioactive isotopes. The largest battery fires are local emergencies, not regional or national catastrophes. The comparison fails at this scale.

The reporting asymmetry between nuclear and battery incidents is one of the most significant analytical gaps in contemporary energy risk policy. Nuclear has mandatory, standardized, internationally harmonized reporting; battery ESS has voluntary, fragmented, jurisdiction-dependent reporting.

NUCLEAR — MANDATORY FRAMEWORK

- **10 CFR 50.72** — Immediate NRC notification for emergency declarations and significant degradation of safety functions
- **10 CFR 50.73** — Licensee Event Reports within 30–60 days for any Level 1+ event
- **INES Rating** — NRC transmits to IAEA for events \geq Level 2; provisional rating issued during event
- **Event Notifications** — Published publicly in NRC ENs database; searchable and tracked
- **WANO / IAEA IRS** — International sharing of operating experience through Incident Reporting System
- **Root Cause Analysis** — Required for significant events; submitted to NRC for review

BATTERY ESS — CURRENT FRAMEWORK

- **NFIRS** — FEMA National Fire Incident Reporting System; captures fire department responses but not root cause; incomplete coverage
- **NERIS** — FEMA's replacement for NFIRS (in development); expected to improve data quality
- **AHJ Emergency Response Plan** — Required by NFPA 855; submitted at commissioning; not public
- **EPRI BESS Incident Database** — Voluntary, researcher-curated; 81 incidents; only 26 with sufficient root-cause data
- **UL Li-ion Incident Reporting** — Tracks incidents but does not disclose individual case details
- **EPA Oversight** — Triggered post-event for environmental monitoring (Gateway 2024, Moss Landing 2025)

INDUSTRY DATABASES COMPARED

- **EPRI BESS Database** — 81 incidents (2011–2024); utility-scale + C&I; no residential; no mandatory disclosure
- **EV FireSafe** — Tracks EV/micro-mobility traction battery fires; statistics but no individual case details
- **IAEA IRS (Nuclear)** — Thousands of operating experience reports; structured taxonomy; internationally accessible
- **NRC ENs** — Immediate notifications database; fully public; timestamped; searchable
- **Key gap:** No BESS database that classifies incidents by outcome severity (only by cause)


STATE-LEVEL BESS REPORTING (US)

- **California** — CPUC/CAISO requires BESS operators to report fire incidents; post-Moss Landing scrutiny heightened
- **New York** — Encouraged OEM root-cause disclosure after incidents; stopped short of mandate in fire code update
- **Massachusetts** — UL 9540 listing required; NFPA 855 enforced through state fire code
- **No federal floor** — DOE Safety Strategic Plan (2024) identifies incident reporting standardization as priority but no regulatory action taken
- **Legal barrier** — RCA findings often protected from disclosure; legal liability concerns suppress transparency


CRITICAL REPORTING GAPS — BATTERY ESS

- ▲ No mandatory federal incident reporting
- ▲ No standardized severity classification for public disclosure
- ▲ No equivalent to NRC Event Notification database
- ▲ Root cause protected by legal privilege in most cases
- ▲ EPRI database has <33% root-cause data coverage
- ▲ No IAEA-equivalent international coordination body
- ▲ NFIRS captures fire response, not ESS-specific failure data


KEY FINDINGS FOR POLICY AND INFRASTRUCTURE ANALYSIS


Incommensurable Hazard Physics


INES measures dispersive radiological contamination at scale; NFPA 855 measures thermochemical energy release in a localized zone. The two frameworks are not competing alternatives — they address different hazard ontologies that lack a shared unit of comparison.


Regulatory Maturity Gap

Nuclear has 35+ years of mandatory, internationally harmonized incident reporting through IAEA/NRC. BESS has voluntary, fragmented, jurisdiction-dependent reporting — roughly where nuclear was in the 1960s. The rapid deployment of GWh-scale BESS is outpacing the development of a commensurate oversight infrastructure.


Post-Event vs. Pre-Event Logic


INES is a post-event severity descriptor used for public communication. NFPA 855 is a pre-incident compliance framework. The battery sector has no equivalent to INES — an event rating that tells regulators and the public “how bad this was” on a standardized scale.


NFPA 855 2026 Paradigm Shift

The 2026 edition’s move away from suppression toward explosion prevention (NFPA 69) + fire containment (burn-out strategy + LSFT) reflects a maturing understanding of Li-ion physics. This mirrors the nuclear sector’s defence-in-depth philosophy — but without the graded severity classification that makes nuclear’s framework analytically powerful.


EUCAR ≠ INES

EUCAR Hazard Levels (0–7) are superficially parallel to INES but describe individual cell test outcomes during design validation — not real-world facility events. A EUCAR Level 7 cell test in a lab has no meaningful equivalence to an INES Level 7 nuclear accident.


The Thermal Runaway – Nuclear Accident Mapping

A rough BESS Stage 3–4 event (installation-level propagation with community evacuation) is operationally comparable to INES 4–5 in terms of emergency response scope. However, the long-term contamination, dose pathways, and geographic scale of true INES 5+ events have no battery analog.

POLICY IMPLICATION FOR GRID-SCALE DEPLOYMENT

As utility-scale BESS installations grow to multi-GWh scale in locations like New York, California, and Texas — often sited in or near dense grid interconnection zones — the absence of a standardized, post-event severity classification system creates an analytic blind spot. The nuclear sector’s INES framework, for all its limitations, enables regulators to benchmark the severity of events across time and geographies. An equivalent BESS event classification standard — one that integrates EUCAR cell-level data, UL 9540A propagation outcomes, and EPRI root-cause taxonomy into a unified, publicly reportable severity number — would represent a significant advancement in grid-level energy storage risk management.

DATE	STAGE	FACILITY / LOCATION	CAPACITY	CHEMISTRY	DURATION	CONTAINMENT OUTCOME	COMMUNITY IMPACT	REGULATORY RESPONSE
MAY 15, 2024	4 INST. CATASTROPHIC	Gateway Energy Storage Otay Mesa / San Diego, CA LS Power · Indoor building	250 MW 250 MWh ~14,796 battery packs	NMC (LG Chem)	13 days Active fire May 15–28; continuous reignition	Fire consumed 1 of 7 sub-buildings (95,000 sq ft). 2.5 million lbs of fire-damaged batteries. 5 million gallons of suppression water applied. 20-month EPA CERCLA cleanup. Building fully dismantled by Jan 2026. Root cause undisclosed (forensic investigation ongoing).	Evacuation orders for adjacent businesses; no residential community evacuation. Air quality monitored — below alarm thresholds due to dilution from suppression water volume.	EPA CERCLA enforcement action (July 2025). CE settlement months of hazmat cleanup oversight. Responsible party: Gateway Energy Storage LLC.
JUL 2024	2 CELL IGNITION	Unnamed BESS Santa Ana, CA (industrial zone) Operator undisclosed	Small-scale industrial	Li-ion (module type unspecified)	~1 hr Brief; localized thermal runaway	Fire confined to originating module. No propagation to adjacent units. Insufficient thermal insulation between cells was cited.	1-hour evacuation of nearby businesses due to toxic smoke concerns. No injuries. Air quality restored quickly.	Local fire department response. No state or federal regulatory action reported.

SEP 5, 2024

3
PROPAGATION

SDG&E
Escondido
Northeast Yard
Escondido, CA
AES Energy
Storage
Substation

30 MW
120 MWh
24
containers

Li-ion
(NMC, 7.6 yr
old)

13 hrs
Fire noon
Sep 5 – 1 AM
Sep 6;
under
maintenance
during event

1 of 24
containers
destroyed. No
propagation to
adjacent
containers — fire
departments
credited
containment
strategy (allow
burn-out +
cooling adjacent
units). Air quality
and water runoff
readings within
acceptable limits.

~500
businesses
evacuated
within ~0.25
mi. Shelter-in-
place for areas
further east.
School
closures.
Evacuation
orders lifted
within ~24 hrs.

SDG&E
regulatory
review. CF
oversight.
EPA
enforcem
action. Ro
cause: po
electrical
or
manufact
defect
(investiga
ongoing a
of reports

JAN 16, 2025

4
INST.
CATASTROPHIC

Vistra Moss
Landing BESS
— Phase 1
(Moss 300)
Monterey
County, CA
Vistra Energy
Indoor
repurposed
power plant
building

300 MW
1,200 MWh
~100,000
battery
modules
55–80%
destroyed




NMC
(LG Energy
Solution
TR1300; 4.1 yr
old)

3+ days
Active
flames to
Jan 18;
smoldering
to Jan 22;
reignition
Feb 2025

55–80% of
~100,000 battery
modules burnt.
Fire confined to
Phase 1 building;
Phases 2 & 3 and
gas plant
unaffected.
Monitor-and-
contain strategy
(allow burn-out).
Soil: Ni, Co, Mn
elevated 100–
1,000× normal.
EPA CERCLA
oversight. Facility
building to be
demolished to
foundation.
Battery removal
ongoing through
2026.

~1,200–1,500
residents
evacuated for
24 hrs. Road
and highway
closures. All
schools closed
1 day. HF
levels below
acute REL
thresholds per
EPA/MBARD.
Residents
reported
rashes, sore
throats,
headaches
post-fire.
Lawsuits filed
(Erin
Brockovich
team).
Community
Assistance
Program
established by
Vistra.
Monterey Co.
EOC activated
at Level 2 (2nd
highest).

EPA NFRA
issued Ja
2025. CEI
enforcem
EPA–Vistra
Settleme
Agreemen
July 2025
CPUC
investigati
ongoing (c
unknown
Jan 2026)
official
compared
event to T
Mile Islan
(INES Lev
Bills intro
to increas
BESS setb
distances.
Moratoriu
enacted ir
Luis Obisp
and Orang
Counties.

MAY 22, 2025	 CELL IGNITION	Digital Realty Data Center BESS Hillsboro, OR Digital Realty · Indoor data center battery room	Backup/UPS battery bank (data center scale)	Li-ion (UPS application)	~5 hrs Alarm 10:20 AM, extinguished 3:30 PM	Fire confined to a single battery room. Firefighters used defensive strategy — allow burn-out, prevent spread to rest of building. Smoke dense and spread through building but no structural spread. All personnel safely evacuated.	No community evacuation. No injuries. Data center operations disrupted.	Local fire department (Hillsboro) response. No state/federal action reported.
JUN 2025	 PROPAGATION	Unidentified BESS Facility Royse City, TX Operator not publicly confirmed	Utility-scale BESS (capacity unconfirmed)	Li-ion (chemistry unspecified)	Multi-hour (exact duration not confirmed publicly)	Multi-unit fire event with visible flames from enclosures. Propagation to adjacent units confirmed by responder accounts. Roads closed. No known injuries.	Road closures. No confirmed community evacuation order. Air quality monitoring initiated.	Local fire department multi-agency response. federal regulatory action confirmed
AUG 30, 2025	 PROPAGATION	California Flats Energy Storage / Parkfield Solar Monterey County, CA Arevon Energy · Solar+storage · Outdoor Tesla Megapacks	240 MW storage 84 Tesla Megapack units 4 units involved	LFP (Tesla Megapack)	<24 hrs Alarm 11 AM Aug 30; extinguished Aug 31; monitoring continued	Fire spread to 4 of 84 Megapack units. Thermal detection system triggered automatically. Tesla Field Services on site. CAL FIRE confirmed extinguished next day and handed over for monitoring. Remaining 80 units unaffected — containment credited to outdoor spacing.	2-mile radius evacuation order issued Aug 30 (5:21 PM) affecting ~5 residences. Lifted ~4 hrs later by Monterey Co. Sheriff. No injuries. No private property damaged.	CAL FIRE response. Field Services on-site monitoring. EPA enforcement action. CAL FIRE under investigation (preliminary TR from cause defect, could be electric fault).

OCT 1, 2025

3
PROPAGATION

SRP Bolster Substation BESS
Glendale–Peoria border, AZ
Salt River Project · Outdoor Tesla Megapacks

25 MW
Outdoor containerized

LFP (Tesla Megapack)

Several hours
System offline; multi-agency response

Visible flames outside enclosures — confirmed propagation beyond initiating container. Adjacent containers cooled with water defensively. Affected unit allowed to burn out under controlled conditions. System offline as of early 2026; no confirmed return-to-service date. No official root cause released.

N. Avenue shut down (W 75th Ave area) for hours. Multi-agency response (Peoria, Phoenix, Glendale FDs). No injuries. No community evacuation order issued.

Local fire agency response. EPA action SRP system remains on as of early 2026.

DEC 19, 2025

2
CELL IGNITION

Church Street Battery Storage Facility
Village of Warwick, NY
Convergent Energy & Power · Powin Centipede units

Small-scale commercial BESS (exact MWh not disclosed)

Li-ion (Powin Centipede)

Active >24 hrs
Alarm 10:15 PM Dec 19; still active Dec 20; site condemned Jan 2026

Fire confined to a single container. No propagation to adjacent units. System idled. **Facility was non-compliant and operating without Certificate of Compliance** at time of fire. Root cause: manufacturing defect in Powin unit allowed water infiltration → electrical fire. Site condemned by Village of Warwick Jan 2026.

Air monitoring by Orange County HazMat: HCN detected at **0.5 ppm near site** (~50% of federal safety limit). Downwind readings: zero. No community evacuation ordered. No injuries. Village pursuing cost recovery and enforcement action against Convergent.

Village of Warwick enforcement action. Site condemned Jan 2026. Orange County HazMat deployment. Operator (Convergent) lacked rec Certificate of Compliance. CTIF report as major regulatory compliance failure. NY State scrutiny elevated.

JAN 21, 2026

2

CELL IGNITION

**Unnamed BESS
Facility**

San Marcos, CA

Operator not
publicly
confirmed -
Outdoor

Utility-
adjacent
BESS
(exact
capacity not
confirmed)

Li-ion
(chemistry
unspecified)

Hours
(fire
controlled
same day)

Fire damages
battery
enclosure.
Contained within
originating unit.
No propagation
reported. San
Marcos adopted
battery storage
guidelines as
regulatory
follow-up (Mar
2025 ordinance
context).

No injuries. No
community
evacuation.
Local roads
monitored.

Local fire
departme
San Marco
City Coun
adopted r
BESS sitin
guidelines
state/fede
action
reported.



Stage 4 — Installation Catastrophic (2 events)

Gateway (May 2024) & Moss Landing (Jan 2025) both reached Stage 4 because fire spread across a significant fraction of the installation (one full sub-building; 55–80% of Phase 1), involved prolonged multi-day burning, triggered EPA CERCLA enforcement actions, required months-to-years of hazmat remediation, and/or caused community evacuations with potential air quality exposure. These are the closest domestic analogs to INES Level 4–5 in terms of emergency response scope and regulatory consequence — though neither produced dispersive long-term radioactive contamination.

Stage 3 — Propagation (4 events)

Escondido, Royse City, Parkfield, Glendale-Peoria all saw thermal runaway spread beyond the originating cell/module to adjacent modules or containers, triggering multi-agency fire response, road closures, and in some cases evacuation orders. Containment was ultimately achieved at the unit or container cluster level. These events are functionally analogous to a BESS installation meeting the UL 9540A unit-level test failure criteria — propagation occurred but was arrested before consuming the full installation.

Stage 2 — Cell Ignition (4 events)

Santa Ana, Hillsboro, Warwick, San Marcos involved confirmed cell or module-level thermal runaway resulting in fire, but containment was achieved within the originating unit or battery room. No propagation to adjacent units was confirmed. In Warwick, regulatory non-compliance elevated the incident's significance beyond the physical Stage 2 outcome — illustrating the gap between containment success and systemic safety failure. The near-threshold HCN reading (0.5 ppm) at Warwick is particularly notable.

Cross-Incident Pattern Analysis

CHEMISTRY

Both Stage 4 events involved **NMC chemistry** — more thermally unstable than the newer LFP. Both Stage 3 events with LFP (Parkfield, Glendale-Peoria) were better contained despite larger installed capacity.

INDOOR VS. OUTDOOR

The two worst events (Gateway, Moss Landing) were **indoor building installations**. All Stage 2–3 events with better outcomes were containerized outdoor systems, consistent with NFPA 855's risk tier hierarchy.

EPA INVOLVEMENT

EPA CERCLA involvement occurred in both Stage 4 events, establishing a de facto threshold: a Stage 4 classification correlates strongly with **federal hazmat jurisdiction**, the closest battery analog to NRC mandatory notification.

REPORTING GAP

Root cause has not been officially confirmed for any of the 10 incidents listed. This classification was conducted entirely from public sources — illustrating the **mandatory reporting vacuum** identified in Section 05.